Washington, Oregon, and British Columbia, but in Alaska it is a summer visitant only (see Swarth, *Alaska Expedition of 1909*, p. 89). Mr. Swarth's recent study of the different races of Fox Sparrows shows that those which pass the summer farthest north have their winter homes in the southern part of the range of the group as a whole. Some other birds show the same tendency. It is easy in Berkeley to observe the migration of Pileolated Warblers after the race which nests in this locality has settled down to domestic life.

If the same thing happens in the case of the Rusty Song Sparrow, it would seem probable that my visitor summers in Alaska, in the only part of the range which does not support these birds during the winter months. A feeding-table in California has proved an attraction which has led the bird to return year after year. But he has never brought another of his own race with him. How much longer will he come? How many years does a migratory bird live?

The evidence presented by the return of the banded Fox Sparrow and the Rusty Song Sparrow seems to show, in addition to the wonderful sense of direction which guides birds in their migrations, a very strong attachment to a locality as long as favorable conditions exist there. They have proved that they can find their way from one spot to another perhaps thousands of miles away and back again to the same spot. If they can and do return to their winter niche, it seems to me not unreasonable to suspect that they may do the same thing in the summer time. Many of the arguments recently presented favoring the theory of a permanent marital tie among birds seem to me to point to the probable remating of a large number of former pairs as brought about by this attachment to a definite locality. Changes effected by tragedies and by the influx of the new generation might account for exceptions to a general rule. Until, at least, more evidence is collected as to the actual return of birds to the same locality, the question of frequent re-mating is not disposed of, no matter how weak the biological evidence for a permanent marital union may be.

Berkeley, California, December 8, 1919.

A PECULIAR FEEDING HABIT OF GREBES

By ALEXANDER WETMORE

MANY ornithologists have commented briefly upon the fact that quantities of feathers almost invariably are present in the stomachs of grebes, a peculiarity that has been without apparent explanation. The present writer through reading and personal observation has been familiar with this condition for many years, and recently, during a study of the food of our North American Grebes (for which the stomachs of nearly four hundred individuals were examined), has had it brought to his attention most forcibly. The following notes based upon personal observation, while presented as theoretical, may be of assistance in throwing light upon the reason for this strange diet.

The stomachs of our grebes are large and capacious, with strong muscular walls, though the thickened lenticular muscle masses characteristic of the gizzards of gallinaceous birds, ducks and others of similar food habit are absent. The upper division of the stomach, the proventriculus, into which the gullet opens, is thick-walled and strongly glandular over its entire inner surface. The stomach proper or ventriculus, as is usual in bird stomachs, has on both sides rounded tendinous areas from which muscle fibers radiate to the margins. On one side the surface of the ventriculus is smoothly rounded, with the fasciae of the muscles radiating over it in bands that are stronger and better marked toward the lateral margins (not toward the anterior or posterior ends of the stomach). On the opposite side of the ventriculus is found a protruding lobe or pyloric bulb of large size that is bent downward; to the lower end of this is attached the duodenum. This pyloric diverticulum extends down to a point level with the central tendon on this face of the ventriculus and by its projection interrupts the even radiation of the muscle on this side. The diverticulum is set at a slight angle with the axis of the stomach, with the point projecting outward. As the muscle band from the central tendon crosses the upper margin of this bulb it becomes much stronger so that here it is five or six times as thick as elsewhere on the stomach. After crossing the lobe the muscle is reduced at once to its normal thickness and proceeds to its insertion at the base of the proventriculus. Examination of the inner structure of the stomach shows that the lobe forms a small chamber opening from the more capacious cavity of the stomach proper. Contraction of the muscle band described above would press the inner wall of the neck of the lobe firmly against the stomach wall opposite, closing off the small chamber completely, and preventing the egress of food matter. It acts therefore as a great valve that opens and closes as needed. The pylorus is constricted to a very small opening, beyond which the canal of the duodenum expands immediately to a diameter three times greater than at the opening.

In the following table are given outside measurements of the stomachs of five species of grebes taken from specimens that were well-filled with food. Stomachs that are nearly empty are contracted so that they appear much smaller, or if crammed may be somewhat larger than the dimensions given here.

OUTSIDE MEASUREMENTS (IN MILLIMETERS) OF STOMACHS OF GREBES

Species	Length of proventriculus	Length of ventriculus	Length of pyloric bulb
Aechmophorus occidentalis	30	80	25
Colymbus holboelli	40	55	25
Colymbus n. californicus	18	38	14
Colymbus auritus	25	40	13
Podilymbus podiceps	28	50	24

With a very few exceptions feathers were present in the stomachs of all of the birds examined. In some individuals the ventriculus was crammed with them; in others the feather content was comparatively small. The pyloric lobe was invariably filled with a plug of feathers (except in the few stomachs that contained no feathers) that had been partly ground up and digested. The feathers in the ventriculus and the pyloric lobe formed two separate well-knit masses that usually could be distinguished without trouble in looking over the contents of the stomach after it had been removed. The proventriculus was always empty, as its function in this group is to supply digestive juices, not to act as a container for food. The feathers swallowed were, in the main, contour feathers from the

breast, with a few from the back. In a few birds taken during the season of molt in August and September, a few primary feathers from the wing were found, but this was unusual.

In field observation the writer frequently has watched Eared Grebes and others preening and dressing the plumage. The body covering of feathers in these birds is dense and heavy, and many feathers are loosened during their active movements. Feathers that came out during preening were occasionally discarded, but more often were dabbled in the water until well moistened and then were swallowed. Occasionally during the breeding season when Eared Grebes were in pairs, feathers discarded by one bird were seized and swallowed by its mate. Parent birds apparently feed feathers to the young as soon as they are large enough to take the food of adults, as fully formed contour feathers were found in the stomachs of young that were still covered with down. It is possible that these young birds picked up floating feathers of their own volition, but it seems more probable that they received them from their parents. These are the only cases in which grebes seemed to eat feathers that were not taken from their own bodies.

After feeding, grebes begin the care of their plumage. The feathers that come out during this process are swallowed and serve to keep the stomach comfortably full as the food elements are prepared and passed on into the intestine. The feathers swallowed are ground up and eventually enter the intestine, though a plug of them remains in the pyloric lobe. These seem to represent the feathers remaining from the preceding meal as they are often more broken than the feathers taken with the food that fills the ventriculus at the time. Thus the plug in the pylorus seemingly is renewed with the digestion of each mass of food. There is evidence to show that when food is abundant grebes feed only once each day, and the feathered plug would therefore be changed once daily.

In the American Anhinga (*Anhinga anhinga*), a fish-eating bird, there is also a pyloric lobe developed in the stomach. This chamber is better separated from the stomach proper than in the grebes and has an additional peculiarity in the development of many very slender, corneous filaments that project as a brush from the surface around the pyloric opening. These point toward the main cavity of the stomach and are thought to act as strainers that prevent the passage of bones and scales into the intestine until they have been properly digested. With this structure in mind it may be suggested that the feathers filling the pyloric cavity in grebes have a similar function. During digestion this plug serves as a strainer that permits the passage of smaller food particles but catches the larger bones and scales of fishes, and the larger chitinous fragments of crustaceans and insects. The plug is probably disintegrated rapidly, but its place is taken immediately by other feathers that have been eaten meanwhile. The habit would seem to be developed mainly in connection with a diet of fish. It was noted that in the Eared Grebe, a species that feeds extensively upon soft-bodied insects and crustacea and takes few fishes, feather remains often were small in quantity, and at times were wanting entirely. Occasionally, in the cases of the Pied-billed and Holboell grebes, the stomach was filled with a mass of feathers with no food remains present. It is possible that these individuals had had difficulty in securing prey but had continued the feather eating habit to aid in satisfying the cravings of hunger.

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